Ecological application of near infrared spectroscopy to test the spatial variability in diet quality in a free-ranging antelope

Gaidet, N.; Ledoze, S.; Lecomte, P.; Hervouet, C. and Bastianelli, D. *

CIRAD Laboratiore d' Alimentation Animale, TA30/A Baillarguet, F34398 Montpellier Cedex 5, France
** Corresponding author. E-mail: denis.bastianelli@cirad.fr*

Testing ecological hypotheses on the nutritional quality of free-ranging herbivores generally requires a large amount of samples. Near infrared (NIR) spectroscopy technology offers the opportunity for ecologists to escape the constraints of laboratory analyses on the design of their investigation. In the present study, we investigated the influence of fine-scale spatial heterogeneity in resource distribution on the habitat-population relationship. In spatially heterogeneous environment, local resource availability and social organisation both determine the distribution of a population. In non-territorial species, individuals can move freely and should be distributed in proportion to the habitat quality. The ideal free distribution hypothesis (IFD) predicts that if rewards are unequal between habitat or sub-areas within the range of a population, individuals would move to better sites until rewards equalize. Following the IDF hypothesis, we tested the prediction that they should be an equal diet quality among habitat types, the between-habitat difference in density balancing the between-habitat difference in forage quality or availability.

The study was conducted on an impala population in a 3,200 ha game ranch of Zimbabwe. We combined estimates of diet quality and population density with a geographic information system, using a systematic sampling design. The study area was stratified in 27 experimental squares, delimited from a grid-network of roads. Local impala densities were estimated from game counts, using a line transect analysis procedure. Diet quality was predicted from faeces samples, using faecal nitrogen (FN) and acid detergent fibre (ADF) as two indicators of the nutritional variability of forage. A total of 300 samples were collected and analysed using NIR spectroscopy procedures. Samples were dried; ground and spectra in diffuse reflectance were measured on a FOSS NIRSystem 6500 spectrometer. Chemical analysis of samples was performed on 89 samples to derive calibration equations using the modified partial least-squares method (MPLS) (WINISI) after mathematical pre-processing using standard normal variate and detrend, second derivative. The high performance of equations, coefficient of determination (R^2) = 0.94 and standard error of cross-validation (SECV) = 0.78 for FN, and R^2 = 0.95 and SECV = 2.37 for ADF, enabled the direct prediction of faecal composition from NIR spectra.

The observed pattern support predictions from the IFD hypothesis. We found no relationship between diet quality and density at the sub-area spatial scale. Despite high variation in local population density (1 to 25 individuals.km^{-2} in experimental squares), the average resource gain per individual was equal among these strata. As predicted, the negative effects of higher density should hence balance the positive effects of quality in best habitats.